



# STP40NF20 - STF40NF20 STB40NF20 - STW40NF20

N-channel 200V - 0.038Ω -40A- D<sup>2</sup>PAK/TO-220/TO-220FP/TO-247  
Low gate charge STripFET™ Power MOSFET

## Features

| Type      | V <sub>DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> | P <sub>W</sub> |
|-----------|------------------|---------------------|----------------|----------------|
| STB40NF20 | 200V             | <0.045Ω             | 40A            | 160W           |
| STP40NF20 | 200V             | <0.045Ω             | 40A            | 160W           |
| STF40NF20 | 200V             | <0.045Ω             | 40A            | 40W            |
| STW40NF20 | 200V             | <0.045Ω             | 40A            | 160W           |

- Gate charge minimized
- Very low intrinsic capacitances
- Very good manufacturing repeatability
- Excellent figure of merit (R<sub>DS</sub>\*Q<sub>g</sub>)
- 100% avalanche tested

## Description

This Power MOSFET series realized with STMicroelectronics unique STripFET process has specifically been designed to minimize input capacitance and gate charge. It is therefore suitable as primary switch in advanced high-efficiency isolated DC-DC converters.

## Applications

- Switching application

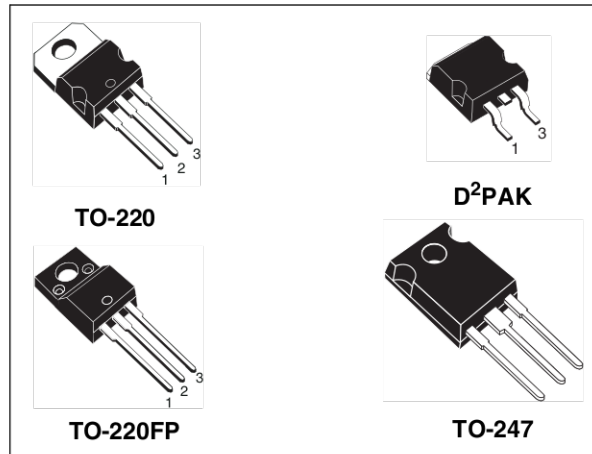


Figure 1. Internal schematic diagram

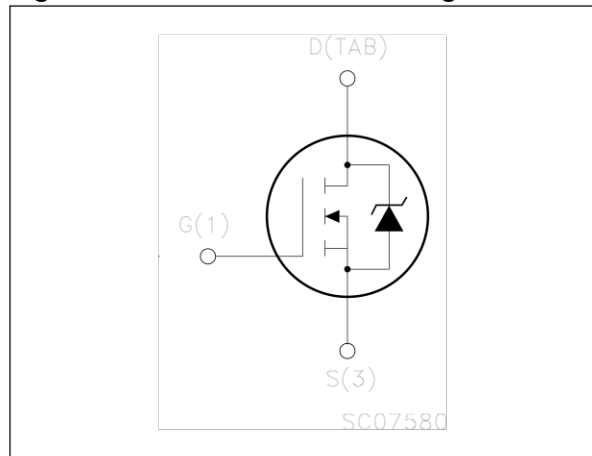


Table 1. Device summary

| Order codes | Marking | Package            | Packaging   |
|-------------|---------|--------------------|-------------|
| STB40NF20   | 40NF20  | D <sup>2</sup> PAK | Tape & reel |
| STP40NF20   | 40NF20  | TO-220             | Tube        |
| STF40NF20   | 40NF20  | TO-220FP           | Tube        |
| STW40NF20   | 40NF20  | TO-247             | Tube        |

# Contents

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol                         | Parameter   | Value                                  |          | Unit |
|--------------------------------|---|--|----------|------|
|                                |   | TO-220<br>D <sup>2</sup> PAK<br>TO-247 | TO-220FP |      |
| V <sub>DS</sub>                | Drain-source voltage (V <sub>GS</sub> = 0)  | 200                                    |          | V    |
| V <sub>GS</sub>                | Gate- source voltage  | ± 20                                   |          | V    |
| I <sub>D</sub> <sup>(1)</sup>  | Drain current (continuous) at T <sub>C</sub> = 25°C   | 40                                     |          | A    |
| I <sub>D</sub> <sup>(1)</sup>  | Drain current (continuous) at T <sub>C</sub> = 100°C  | 25                                     |          | A    |
| I <sub>DM</sub> <sup>(2)</sup> | Drain current (pulsed)  | 160                                    |          | A    |
| P <sub>tot</sub>               | Total dissipation at T <sub>C</sub> = 25°C  | 160                                    | 40       | W    |
|                                | Derating Factor   | 1.28                                   | 0.32     | W/°C |
| dv/dt <sup>(3)</sup>           | Peak diode recovery voltage slope   | 12                                     |          | V/ns |
| V <sub>ISO</sub>               | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1s; T <sub>c</sub> = 25°C) | --                                     | 2500     | V    |
| T <sub>stg</sub>               | Storage temperature   | -55 to 150                             |          | °C   |
| T <sub>j</sub>                 | Max. operating junction temperature   |  |          |      |

- Value limited by wire bonding
- Pulse width limited by safe operating area.
- I<sub>SD</sub> ≤ 40A, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>j</sub> ≤ T<sub>JMAX</sub>

**Table 2. Thermal data**

| Symbol                | Parameter   | TO-220<br>D <sup>2</sup> PAK | TO-247 | TO-220FP | Unit |
|-----------------------|---|------------------------------|--------|----------|------|
| R <sub>thj-case</sub> | Thermal resistance junction-case max                          | 0.78                         |        | 3.1      | °C/W |
| R <sub>thj-amb</sub>  | Thermal resistance junction-ambient max                       | 62.5                         | 50     | 62.5     | °C/W |
| T <sub>J</sub>        | Maximum lead temperature for soldering purpose <sup>(1)</sup> | 300                          |        |          | °C   |

- for 10 sec. 1.6mm from case

**Table 3. Avalanche characteristics**

| Symbol          | Parameter  | Max value | Unit |
|-----------------|--|-----------|------|
| I <sub>AR</sub> | Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>j</sub> max)                                | 40        | A    |
| E <sub>AS</sub> | Single pulse avalanche energy (starting T <sub>j</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V) | 230       | mJ   |

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}C$  unless otherwise specified)

**Table 4. On/off states**

| Symbol        | Parameter  | Test conditions   | Min. | Typ.  | Max.      | Unit               |
|---------------|--|---|------|-------|-----------|--------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage                   | $I_D = 1mA, V_{GS} = 0$   | 200  |       |           | V                  |
| $I_{DSS}$     | Zero gate voltage drain current ( $V_{GS} = 0$ ) | $V_{DS} = \text{max ratings}$<br>$V_{DS} = \text{max ratings}@125^{\circ}C$ |      |       | 1<br>10   | $\mu A$<br>$\mu A$ |
| $I_{GSS}$     | Gate-body leakage current ( $V_{DS} = 0$ )       | $V_{GS} = \pm 20V$  |      |       | $\pm 100$ | nA                 |
| $V_{GS(th)}$  | Gate threshold voltage                           | $V_{DS} = V_{GS}, I_D = 250\mu A$   | 2    | 3     | 4         | V                  |
| $R_{DS(on)}$  | Static drain-source on resistance                | $V_{GS} = 10V, I_D = 20A$   |      | 0.038 | 0.045     | $\Omega$           |

**Table 5. Dynamic**

| Symbol  | Parameter   | Test conditions   | Min. | Typ.                 | Max. | Unit                 |
|---|---|---|------|----------------------|------|----------------------|
| $g_{fs}^{(1)}$                                | Forward transconductance  | $V_{DS} = 15V, I_D = 20A$   |      | 30                   |      | S                    |
| $C_{iss}$<br>$C_{oss}$<br>$C_{rss}$           | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{DS} = 25V, f = 1MHz,$<br>$V_{GS} = 0$   |      | 2500<br>510<br>78    |      | pF<br>pF<br>pF       |
| $t_{d(on)}$<br>$t_r$<br>$t_{d(off)}$<br>$t_f$ | Turn-on delay time<br>Rise time<br>Turn-off delay time<br>Fall time     | $V_{DD} = 100V, I_D = 20A$<br>$R_G = 4.7\Omega, V_{GS} = 10V$<br>(see <a href="#">Figure 17</a> ) |      | 20<br>44<br>74<br>22 |      | ns<br>ns<br>ns<br>ns |
| $Q_g$<br>$Q_{gs}$<br>$Q_{gd}$                 | Total gate charge<br>Gate-source charge<br>Gate-drain charge            | $V_{DD} = 160V, I_D = 40A,$<br>$V_{GS} = 10V$<br>(see <a href="#">Figure 18</a> )                 |      | 75<br>13.2<br>35.5   |      | nC<br>nC<br>nC       |

1. Pulsed: Pulse duration = 300  $\mu s$ , duty cycle 1.5%.

**Table 6. Source drain diode**

| Symbol                            | Parameter  | Test conditions   | Min. | Typ.                | Max.      | Unit          |
|-----------------------------------|--|---|------|---------------------|-----------|---------------|
| $I_{SD}$<br>$I_{SDM}^{(1)}$       | Source-drain current<br>Source-drain current<br>(pulsed)                     |   |      |                     | 40<br>160 | A<br>A        |
| $V_{SD}^{(2)}$                    | Forward on voltage   | $I_{SD} = 20A, V_{GS} = 0$  |      |                     | 1.5       | V             |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD} = 20A,$<br>$di/dt = 100A/\mu s,$<br>$V_{DD} = 25V$<br>(see <a href="#">Figure 19</a> )                    |      | 192<br>922<br>9.6   |           | ns<br>nC<br>A |
| $t_{rr}$<br>$Q_{rr}$<br>$I_{RRM}$ | Reverse recovery time<br>Reverse recovery charge<br>Reverse recovery current | $I_{SD} = 20A,$<br>$di/dt = 100A/\mu s,$<br>$V_{DD} = 25V, T_j = 150^\circ C$<br>(see <a href="#">Figure 19</a> ) |      | 242<br>1440<br>11.9 |           | ns<br>nC<br>A |

1. Pulse width limited by safe operating area.
2. Pulsed: Pulse duration = 300  $\mu s$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220/D<sup>2</sup>PAK

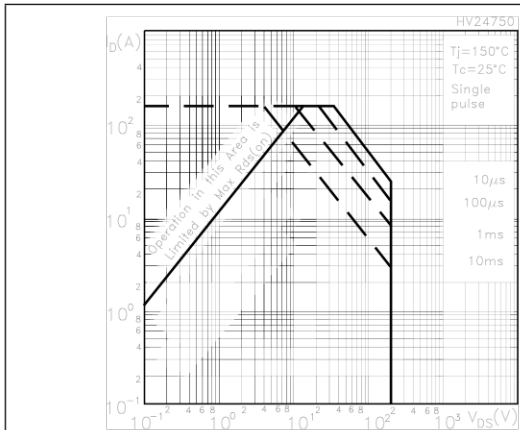


Figure 3. Thermal impedance area for TO-220/D<sup>2</sup>PAK

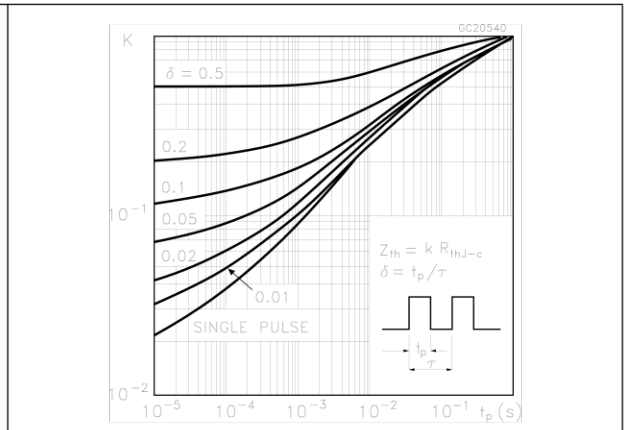


Figure 4. Safe operating area for TO-247

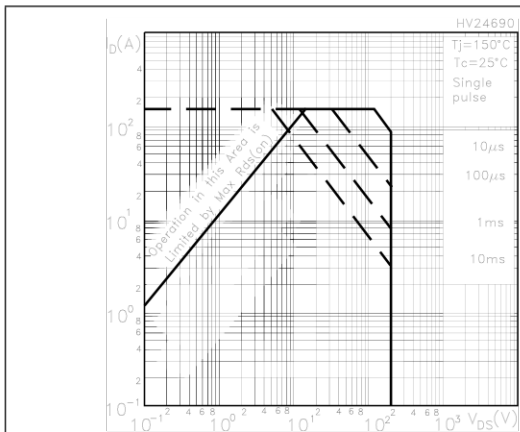


Figure 5. Thermal impedance for TO-247

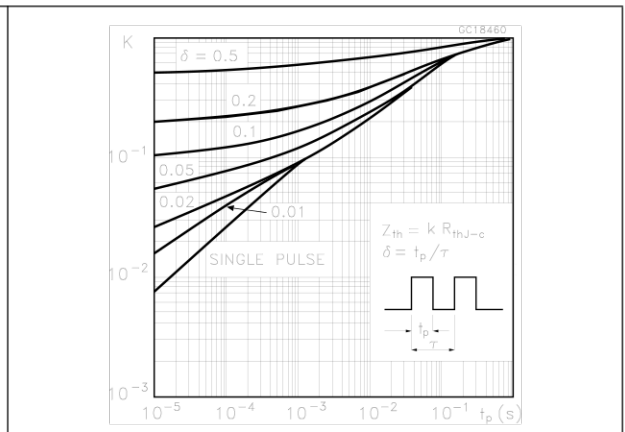


Figure 6. Safe operating area for TO-220FP

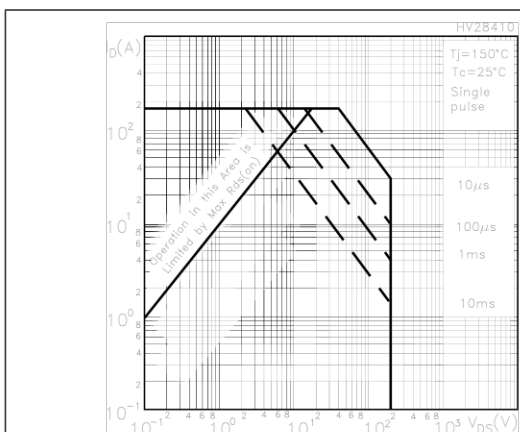


Figure 7. Thermal impedance for TO-220FP

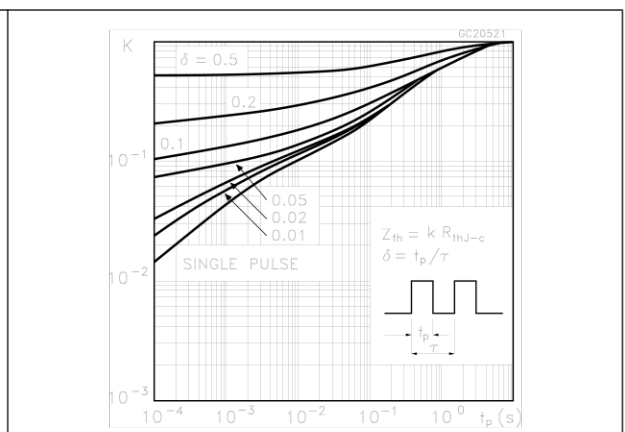


Figure 8. Output characteristics

Figure 9. Transfer characteristics

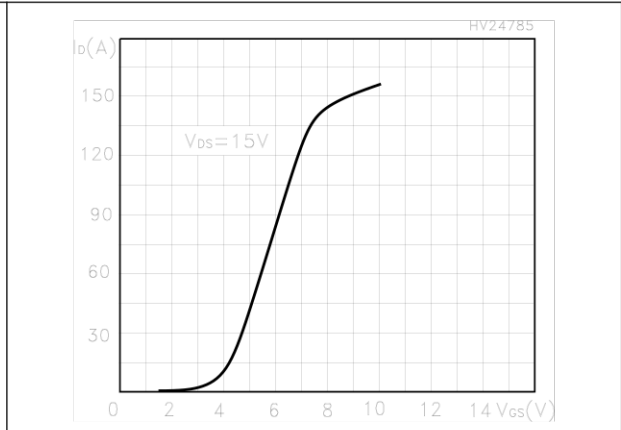
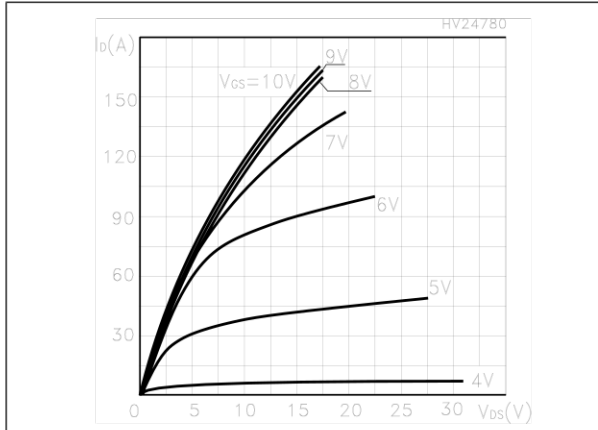


Figure 10. Transconductance

Figure 11. Static drain-source on resistance

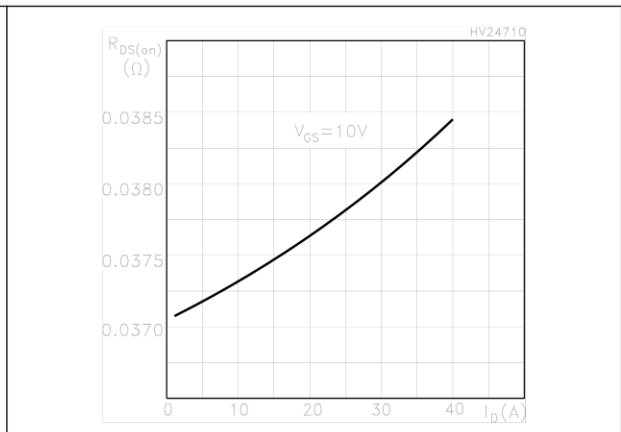
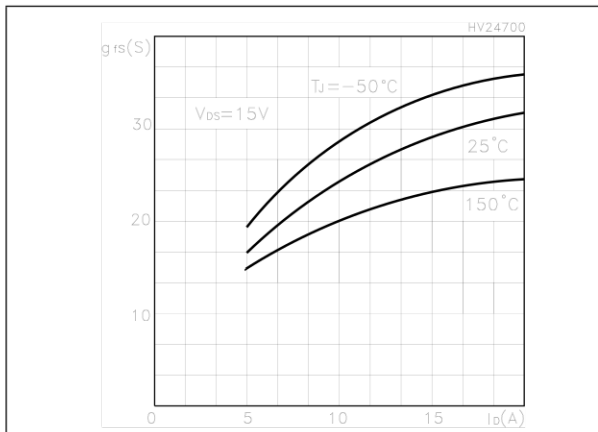


Figure 12. Gate charge vs gate-source voltage

Figure 13. Capacitance variations

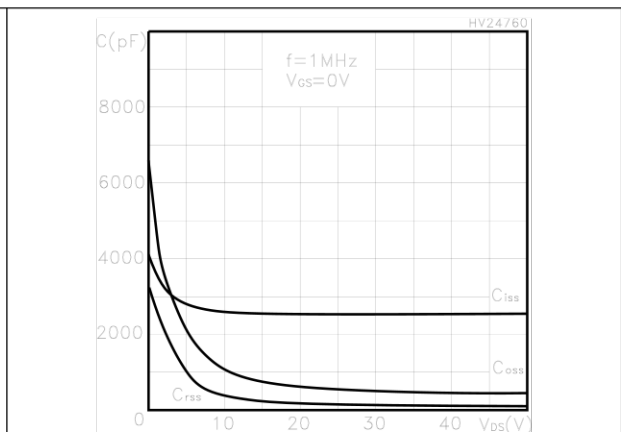
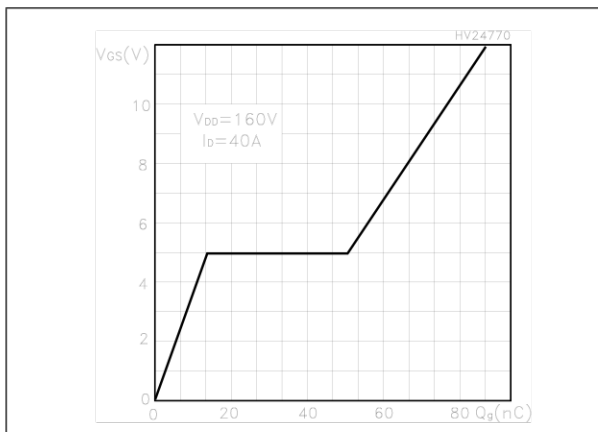


Figure 14. Normalized gate threshold voltage vs temperature

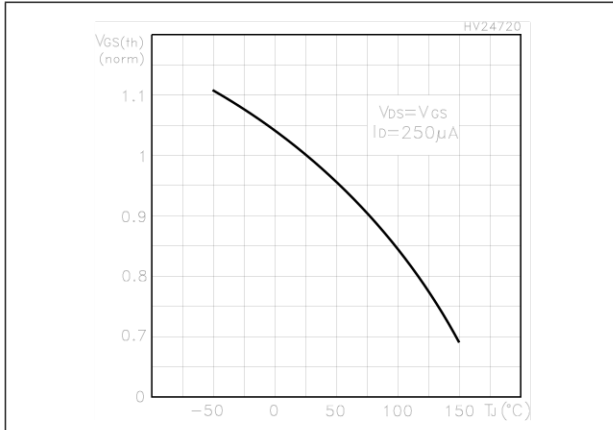


Figure 15. Normalized on resistance vs temperature

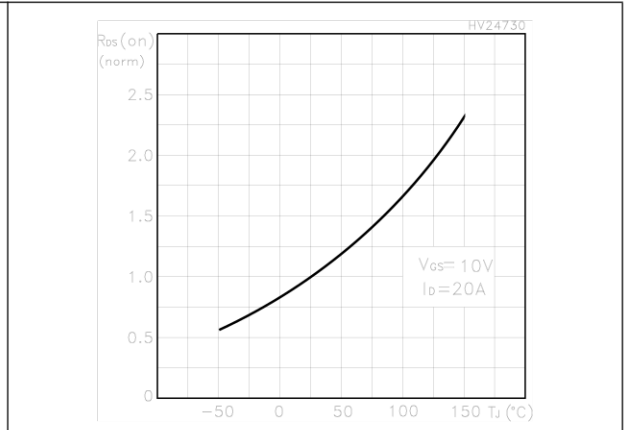
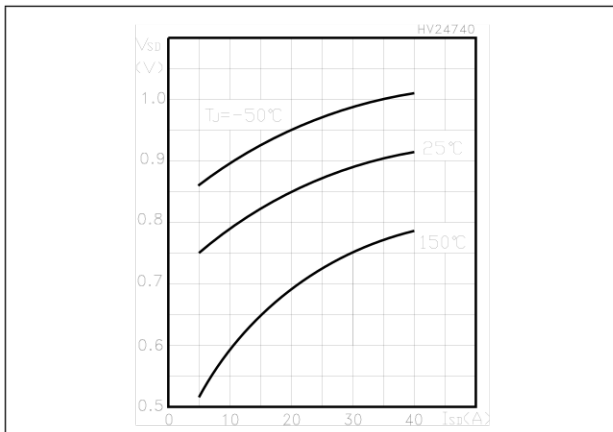


Figure 16. Source-drain diode forward characteristics





### 3 Test circuit

Figure 17. Switching times test circuit for resistive load

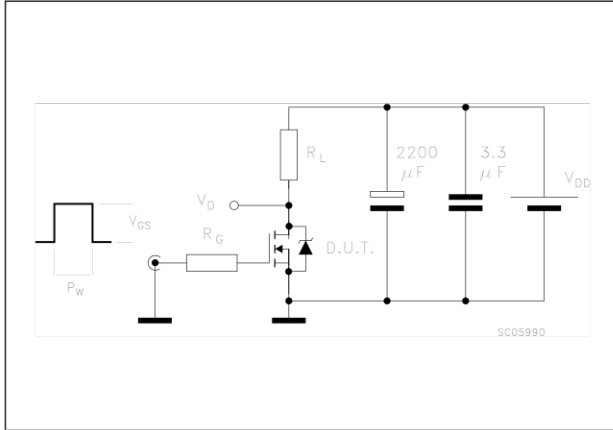


Figure 18. Gate charge test circuit

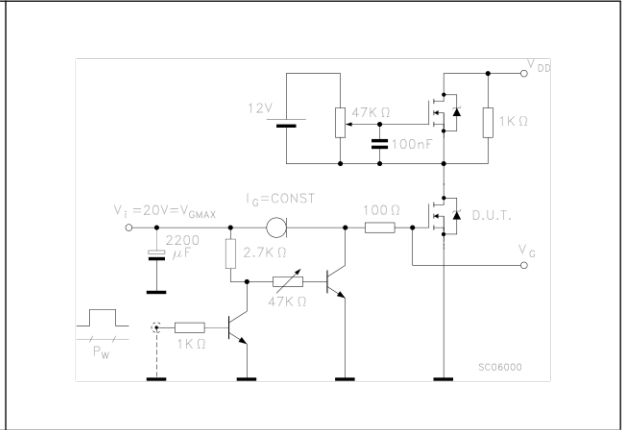


Figure 19. Test circuit for inductive load switching and diode recovery times

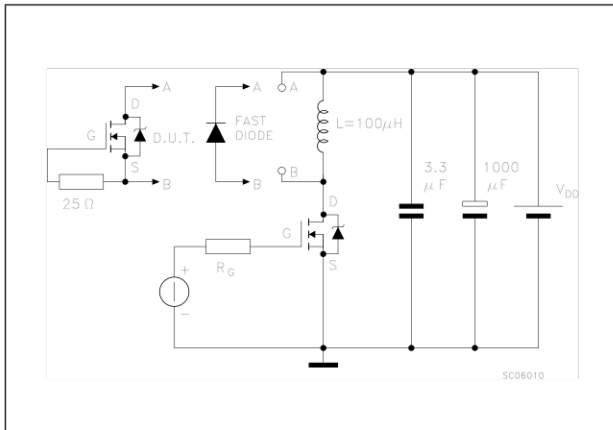


Figure 20. Unclamped Inductive load test circuit

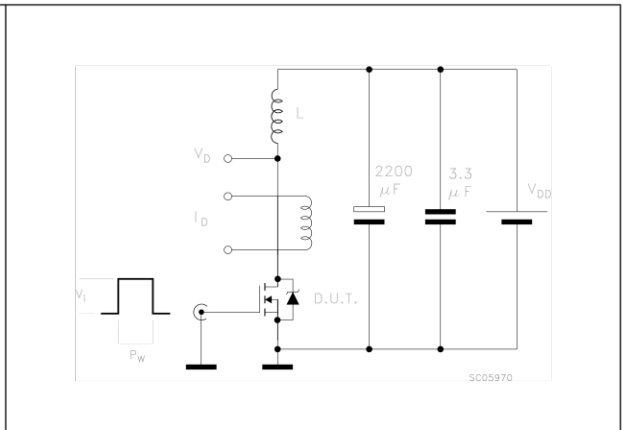


Figure 21. Unclamped inductive waveform

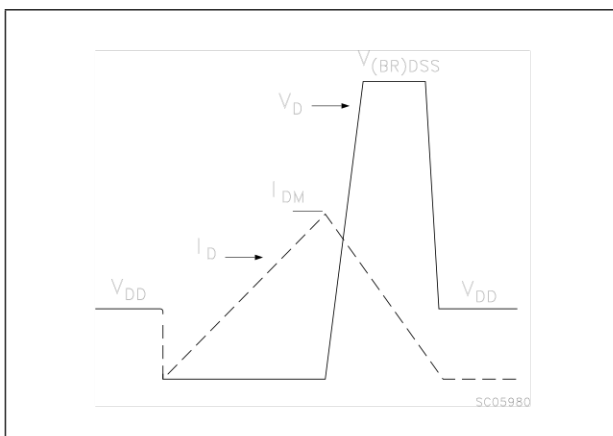
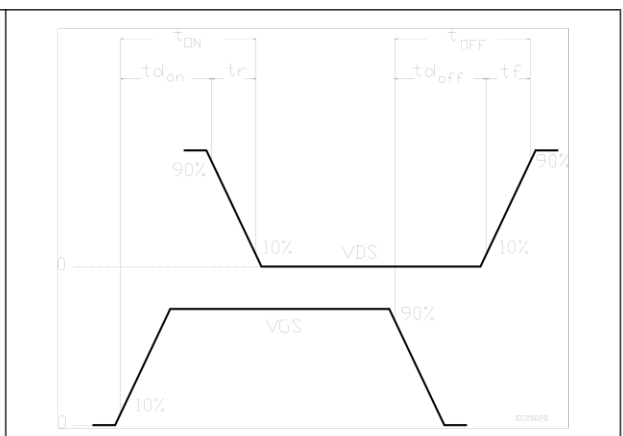


Figure 22. Switching time waveform

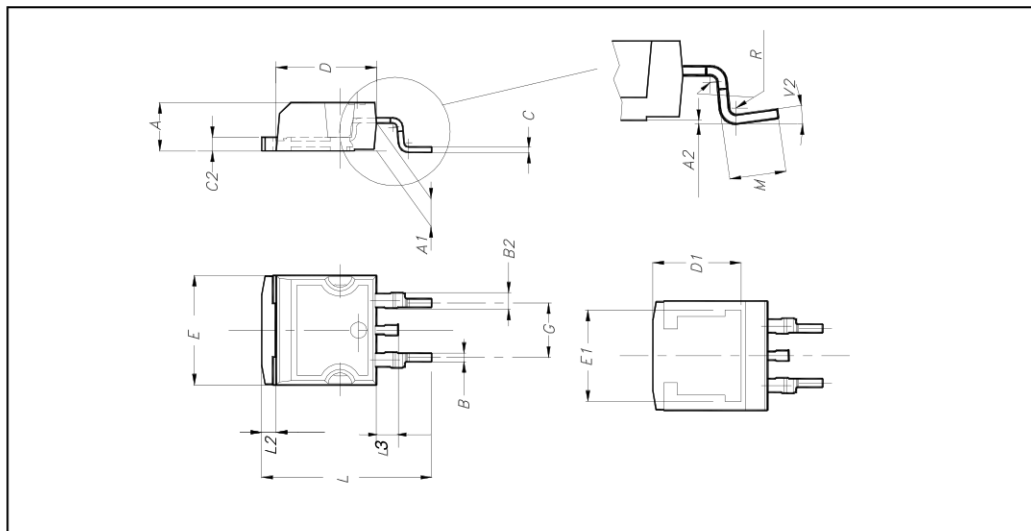


## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com)

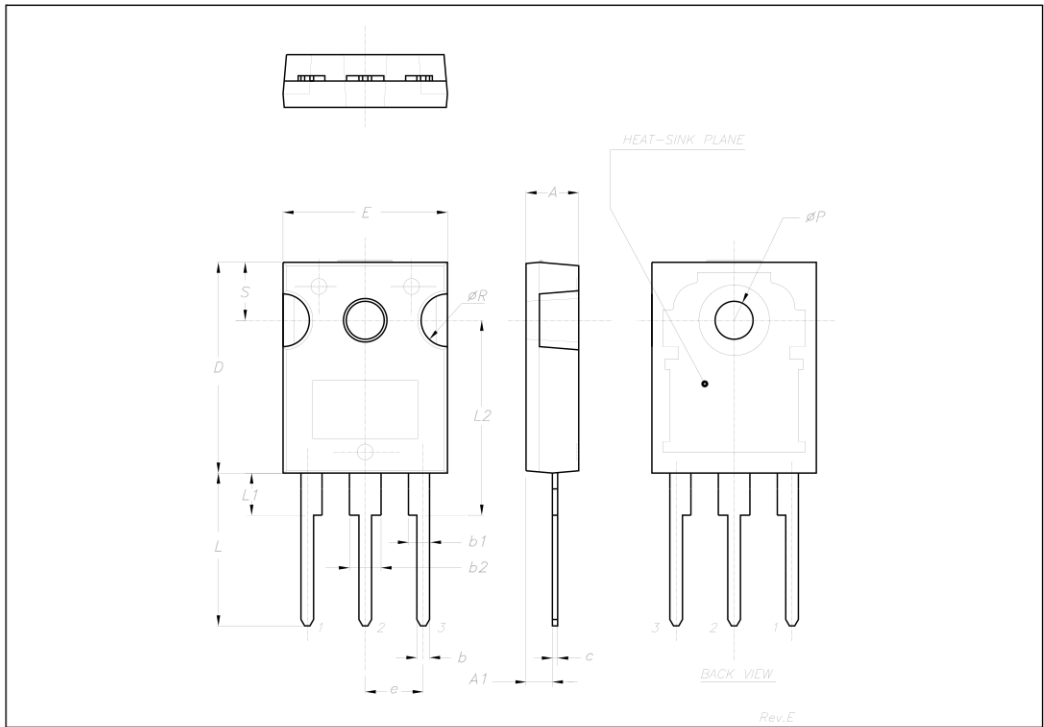
**D<sup>2</sup>PAK MECHANICAL DATA**

| DIM. | mm.  |      |       | inch  |       |       |
|------|------|------|-------|-------|-------|-------|
|      | MIN. | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |      | 4.6   | 0.173 |       | 0.181 |
| A1   | 2.49 |      | 2.69  | 0.098 |       | 0.106 |
| A2   | 0.03 |      | 0.23  | 0.001 |       | 0.009 |
| B    | 0.7  |      | 0.93  | 0.027 |       | 0.036 |
| B2   | 1.14 |      | 1.7   | 0.044 |       | 0.067 |
| C    | 0.45 |      | 0.6   | 0.017 |       | 0.023 |
| C2   | 1.23 |      | 1.36  | 0.048 |       | 0.053 |
| D    | 8.95 |      | 9.35  | 0.352 |       | 0.368 |
| D1   |      | 8    |       |       | 0.315 |       |
| E    | 10   |      | 10.4  | 0.393 |       |       |
| E1   |      | 8.5  |       |       | 0.334 |       |
| G    | 4.88 |      | 5.28  | 0.192 |       | 0.208 |
| L    | 15   |      | 15.85 | 0.590 |       | 0.625 |
| L2   | 1.27 |      | 1.4   | 0.050 |       | 0.055 |
| L3   | 1.4  |      | 1.75  | 0.055 |       | 0.068 |
| M    | 2.4  |      | 3.2   | 0.094 |       | 0.126 |
| R    |      | 0.4  |       |       | 0.015 |       |
| V2   | 0°   |      | 4°    |       |       |       |



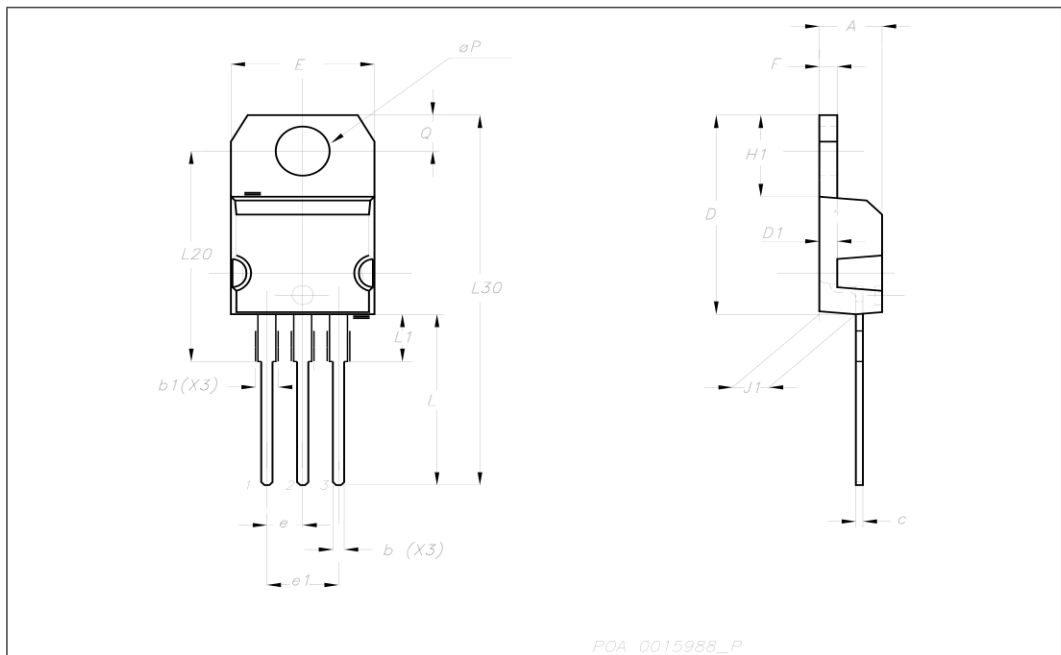
**TO-247 MECHANICAL DATA**

| DIM. | mm.   |       |       | inch  |       |       |
|------|-------|-------|-------|-------|-------|-------|
|      | MIN.  | TYP.  | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 4.85  |       | 5.15  | 0.19  |       | 0.20  |
| A1   | 2.20  |       | 2.60  | 0.086 |       | 0.102 |
| b    | 1.0   |       | 1.40  | 0.039 |       | 0.055 |
| b1   | 2.0   |       | 2.40  | 0.079 |       | 0.094 |
| b2   | 3.0   |       | 3.40  | 0.118 |       | 0.134 |
| c    | 0.40  |       | 0.80  | 0.015 |       | 0.03  |
| D    | 19.85 |       | 20.15 | 0.781 |       | 0.793 |
| E    | 15.45 |       | 15.75 | 0.608 |       | 0.620 |
| e    |       | 5.45  |       |       | 0.214 |       |
| L    | 14.20 |       | 14.80 | 0.560 |       | 0.582 |
| L1   | 3.70  |       | 4.30  | 0.14  |       | 0.17  |
| L2   |       | 18.50 |       |       | 0.728 |       |
| øP   | 3.55  |       | 3.65  | 0.140 |       | 0.143 |
| øR   | 4.50  |       | 5.50  | 0.177 |       | 0.216 |
| S    |       | 5.50  |       |       | 0.216 |       |



TO-220 mechanical data

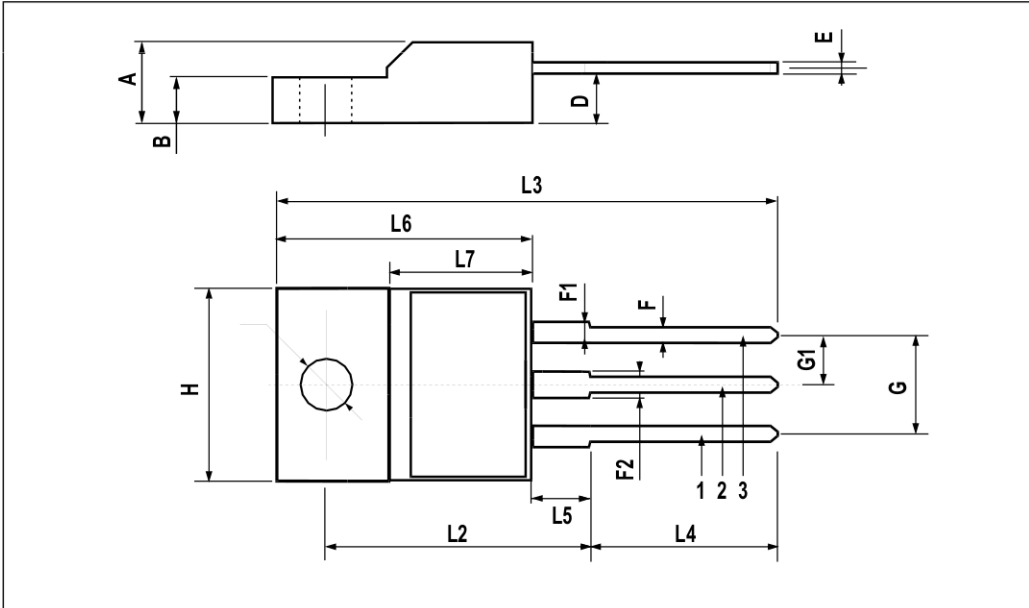
| Dim | mm    |       |       | inch  |       |       |
|-----|-------|-------|-------|-------|-------|-------|
|     | Min   | Typ   | Max   | Min   | Typ   | Max   |
| A   | 4.40  |       | 4.60  | 0.173 |       | 0.181 |
| b   | 0.61  |       | 0.88  | 0.024 |       | 0.034 |
| b1  | 1.14  |       | 1.70  | 0.044 |       | 0.066 |
| c   | 0.49  |       | 0.70  | 0.019 |       | 0.027 |
| D   | 15.25 |       | 15.75 | 0.6   |       | 0.62  |
| D1  |       | 1.27  |       |       | 0.050 |       |
| E   | 10    |       | 10.40 | 0.393 |       | 0.409 |
| e   | 2.40  |       | 2.70  | 0.094 |       | 0.106 |
| e1  | 4.95  |       | 5.15  | 0.194 |       | 0.202 |
| F   | 1.23  |       | 1.32  | 0.048 |       | 0.051 |
| H1  | 6.20  |       | 6.60  | 0.244 |       | 0.256 |
| J1  | 2.40  |       | 2.72  | 0.094 |       | 0.107 |
| L   | 13    |       | 14    | 0.511 |       | 0.551 |
| L1  | 3.50  |       | 3.93  | 0.137 |       | 0.154 |
| L20 |       | 16.40 |       |       | 0.645 |       |
| L30 |       | 28.90 |       |       | 1.137 |       |
| ∅P  | 3.75  |       | 3.85  | 0.147 |       | 0.151 |
| Q   | 2.65  |       | 2.95  | 0.104 |       | 0.116 |



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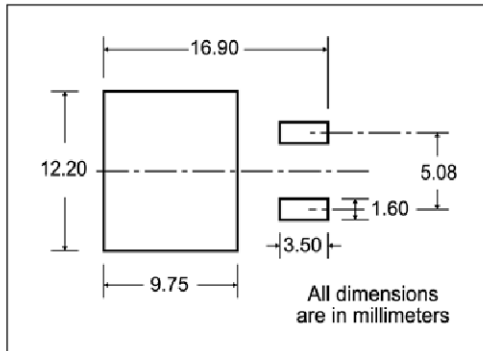
**TO-220FP MECHANICAL DATA**

| DIM. | mm.  |     |      | inch  |       |       |
|------|------|-----|------|-------|-------|-------|
|      | MIN. | TYP | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 4.4  |     | 4.6  | 0.173 |       | 0.181 |
| B    | 2.5  |     | 2.7  | 0.098 |       | 0.106 |
| D    | 2.5  |     | 2.75 | 0.098 |       | 0.108 |
| E    | 0.45 |     | 0.7  | 0.017 |       | 0.027 |
| F    | 0.75 |     | 1    | 0.030 |       | 0.039 |
| F1   | 1.15 |     | 1.7  | 0.045 |       | 0.067 |
| F2   | 1.15 |     | 1.7  | 0.045 |       | 0.067 |
| G    | 4.95 |     | 5.2  | 0.195 |       | 0.204 |
| G1   | 2.4  |     | 2.7  | 0.094 |       | 0.106 |
| H    | 10   |     | 10.4 | 0.393 |       | 0.409 |
| L2   |      | 16  |      |       | 0.630 |       |
| L3   | 28.6 |     | 30.6 | 1.126 |       | 1.204 |
| L4   | 9.8  |     | 10.6 | .0385 |       | 0.417 |
| L5   | 2.9  |     | 3.6  | 0.114 |       | 0.141 |
| L6   | 15.9 |     | 16.4 | 0.626 |       | 0.645 |
| L7   | 9    |     | 9.3  | 0.354 |       | 0.366 |
| Ø    | 3    |     | 3.2  | 0.118 |       | 0.126 |



## 5 Packaging mechanical data

### D<sup>2</sup>PAK FOOTPRINT



### TAPE AND REEL SHIPMENT

40 mm min. Access hole at slot location

Full radius

Tape slot in core for tape start 2.5mm min. width

G measured at hub

#### REEL MECHANICAL DATA

| DIM. | mm   |      | inch  |        |
|------|------|------|-------|--------|
|      | MIN. | MAX. | MIN.  | MAX.   |
| A    |      | 330  |       | 12.992 |
| B    | 1.5  |      | 0.059 |        |
| C    | 12.8 | 13.2 | 0.504 | 0.520  |
| D    | 20.2 |      | 0.795 |        |
| G    | 24.4 | 26.4 | 0.960 | 1.039  |
| N    | 100  |      | 3.937 |        |
| T    |      | 30.4 |       | 1.197  |

| BASE QTY | BULK QTY |
|----------|----------|
| 1000     | 1000     |

#### TAPE MECHANICAL DATA

| DIM. | mm   |      | inch   |        |
|------|------|------|--------|--------|
|      | MIN. | MAX. | MIN.   | MAX.   |
| A0   | 10.5 | 10.7 | 0.413  | 0.421  |
| B0   | 15.7 | 15.9 | 0.618  | 0.626  |
| D    | 1.5  | 1.6  | 0.059  | 0.063  |
| D1   | 1.59 | 1.61 | 0.062  | 0.063  |
| E    | 1.65 | 1.85 | 0.065  | 0.073  |
| F    | 11.4 | 11.6 | 0.449  | 0.456  |
| K0   | 4.8  | 5.0  | 0.189  | 0.197  |
| P0   | 3.9  | 4.1  | 0.153  | 0.161  |
| P1   | 11.9 | 12.1 | 0.468  | 0.476  |
| P2   | 1.9  | 2.1  | 0.075  | 0.082  |
| R    | 50   |      | 1.574  |        |
| T    | 0.25 | 0.35 | 0.0098 | 0.0137 |
| W    | 23.7 | 24.3 | 0.933  | 0.956  |

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

FEED DIRECTION

Bending radius R min.

\* on sales type

## 6 Revision history

Table 7. Revision history

| Date        | Revision | Changes                                 |
|-------------|----------|---|
| 25-Jan-2007 | 1        | First version                           |
| 06-Jul-2007 | 2        | Correctet Ptot value on <i>Features</i> |



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